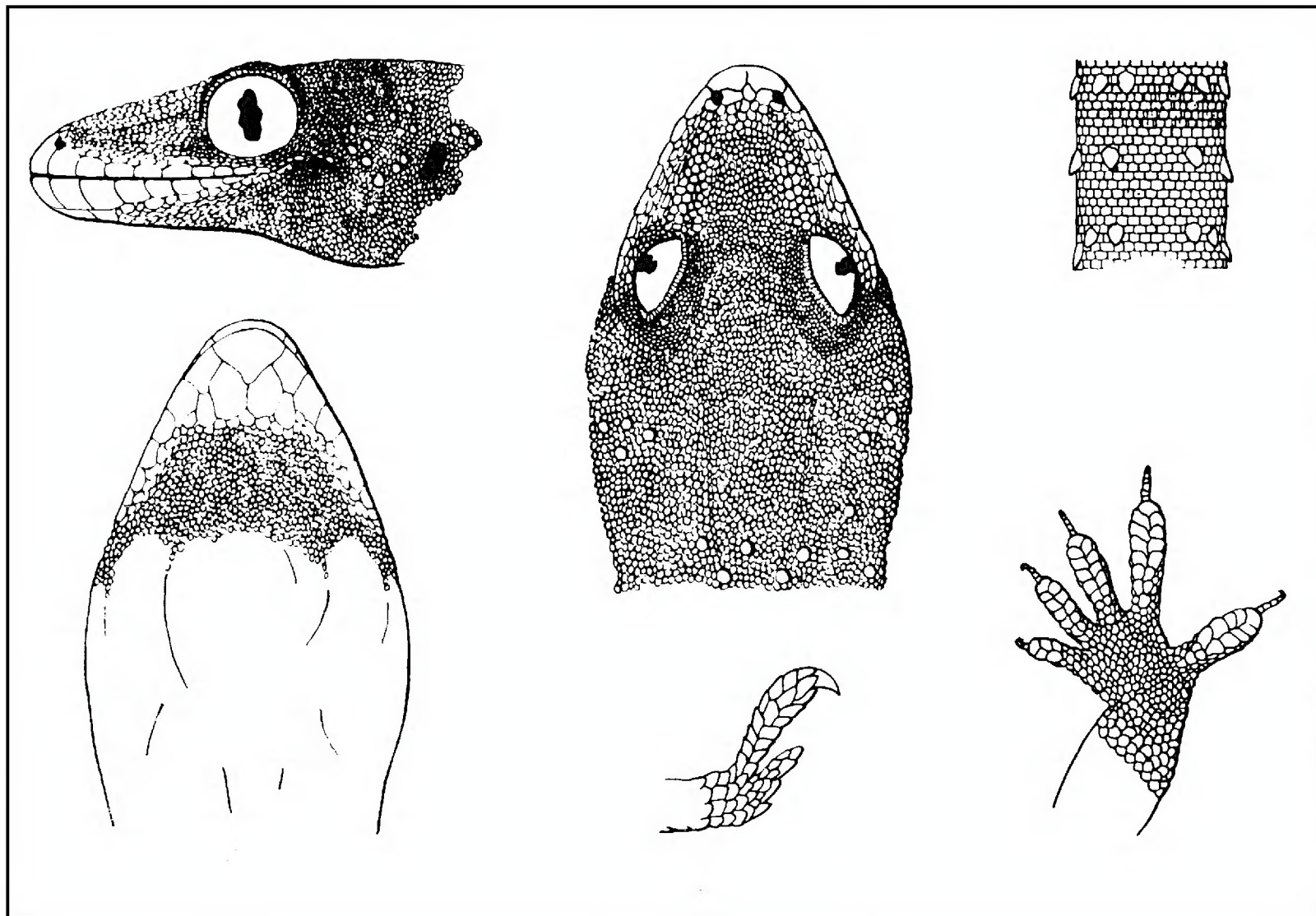

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A Discussion of Two Methods of Modeling Suitable Climate for the Burmese Python, *Python bivittatus*, with Comments on Rodda, Jarnevich and Reed (2011)

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Overview

In late February 2008, the online version of a paper by Gordon H. Rodda, Catherine S. Jarnevich and Robert N. Reed was posted on the *Biological Invasions* website. This paper predicted that suitable climate for Burmese pythons [then *Python molurus bivittatus*] existed in a wide swath across the southern third of the continental USA. It was accompanied by a USGS press release that implied that *bivittatus* could and would likely rapidly spread from its established population in the Everglades region of extreme southern Florida into this region of suitable climate. This paper was published in print in *Biological Invasions* in 2009; references to this one paper are cited as either Rodda et al. (2008) or Rodda et al. (2009).

The USGS press release incited a glut of articles and interviews in which the actual conclusions of the paper were grossly misinterpreted by the media, the authors, and just about anyone willing to state that this country would soon be overrun by pythons. As examples, in the 21 February 2008 edition of the *San Francisco Chronicle*, Skip Snow of the National Park Service was quoted as saying that already one python crawled 100 miles north to the shore of Lake Okeechobee. Gordon Rodda stated: “At 20 miles a month, a determined Burmese python from Florida could arrive in San Francisco as early as August 2020. It would be exceptional for one animal to be that unidirectional in its movement, but it’s mathematically possible,” Rodda said. “The snake’s cross-country crawl would be made easier by the large population of beavers along the way,” Rodda said. “. . . No beaver would be safe from a python.” On 22 February 2008, the story was on the front page of *USA Today*. Also on 22 February 2008, the *Atlantic Journal* quoted Robert Reed stating that when pythons made it to Georgia “They will chow down on pigs. They will chow down on turkeys.”

In August 2008, a paper by R. Alexander Pyron, Frank T. Burbrink and Timothy J. Guiher appeared in the online journal *PLoS ONE*. The authors created what they termed an “ecological niche model” for Burmese pythons. As shown in Figure 1, when this model was applied to the USA, its predictions of suitable space were far more conservative than those of Rodda et al. (2008) seen in Figure 2. The paper also included a critical analysis of the data and methods of analysis used by Rodda et al. (2008).

Important to this timeline, a paper published in 2009 argued that the Burmese python is properly classified as a species, *Python bivittatus* (Jacobs et al., 2009). This change has been largely rejected by researchers associated with agencies of the Department of the Interior, but has been accepted and used by most authors (for examples see Barker and Barker, 2010a, b, c; Cota, 2010; Engeman et al., 2011; Krysko et al., 2011).

In February 2011, Rodda, Jarnevich and Reed published another article on the topic of suitable climate space for Burmese pythons. This paper attempts to explain why their method of predicting suitable climate space is both technically and

fundamentally a better way to do climate matching than the method employed by Pyron et al. (2008), and includes a critical review of that analysis. Rodda et al. (2011) admit that there is controversy in the “scientific community” over the optimal method to do climate matching, and discuss some of the reasons underlying the controversy.

Climate space models

In the climate matching studies done for *molurus/bivittatus*, Rodda et al. (2008) and Pyron et al. (2008) use locality information based on the native ranges of the two taxa, combined with climatic data from those areas to generate models describing the suitable climate space for these taxa. These climate space models can be “fitted” to extralimital geographic areas to identify areas exhibiting the same or similar climate space.

For example, the climate space derived for *molurus/bivittatus* by Rodda et al. (2008) is based on 149 locality points, and data for the mean monthly precipitation and the mean monthly temperature at each of these points comprise the data set. These variables from 149 locality points are analyzed to create a climate space model. This defined climate space is then “fitted” to areas with similar climate, with those areas then identified as suitable extralimital climate for the potential invasive species.

To define the climate space of *molurus/bivittatus*, Rodda et al. (2008) selected locality points from around the periphery of the ranges of *molurus* and *bivittatus*. [Curiously, it is stated that the data from two additional localities were added to the original data set of 149 reporting stations—this undoubtedly has some significance, but those new localities are not identified, and any analyses made beyond that in Rodda et al. (2008) and Reed and Rodda (2009) are not illustrated or discussed.] According to the authors, the actual presence or absence of pythons at the locality points is not considered to be important; however, Pyron et al. (2008) criticizes this as a serious fault of the analysis of Rodda et al. (2008). It is a fact that a significant number of the locality points selected by Rodda et al. (2008) are well outside both geographical and elevational ranges of both *molurus* and *bivittatus*. [See Barker and Barker (2010c) for details.]

Pyron et al. (2008) took a different tack and used 90 locality points that were based on the localities and elevations of actual python specimens, referred to as “presence localities.” The climate data utilized in this analysis were taken from the BioClim data set. The locality points and climate data were analyzed using MaxEnt, a software program that implements a statistical algorithm for maximum entropy modeling. MaxEnt was used by Pyron et al. (2008) to generate the map of potential suitable climate for the *molurus/bivittatus* combination in the continental USA.

The program MaxEnt allows for a greater number of variables to be used in the analysis of native climate space than the method used in Rodda et al. (2008), and the variables can be weighted for importance. Pyron et al. (2008) described this as

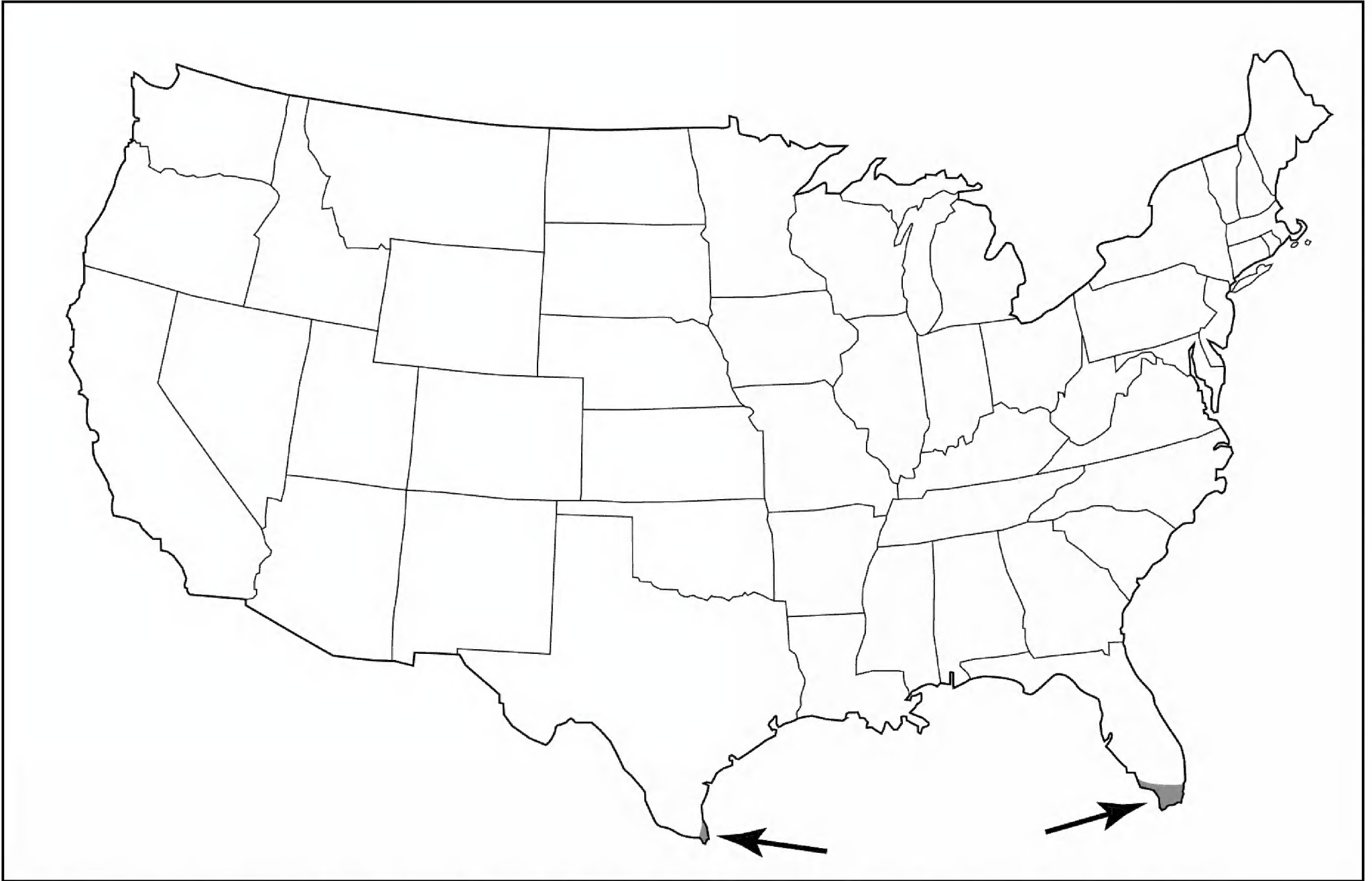


Figure 1. The two small gray-shaded areas represent the areas of suitable climate in the continental USA as predicted by Pyron et al. (2008).



Figure 2. The gray-shaded areas represent the areas of suitable climate in the continental USA as predicted by Rodda et al. (2008).

“ecological niche modeling” versus the climate space modeling of Rodda et al. (2008). However, Rodda et al. (2011) dispute this, saying that the space that MaxEnt identifies is not a niche space and then refer to it in the remainder of the paper as climate space. The map of suitable climate space in the continental USA generated by Pyron et al. (2008) is far more conservative than that of Rodda et al. (2008).

Rodda et al. (2011) emphasize one issue that they consider to be key when analyzing climate space. They discuss that there are two types of climate space, which they identify as “fundamental climate space” and “realized climate space.”

The **fundamental climate space** of a species is the climate space in which a species could survive without regard to the other biotic and abiotic factors that limit the species in its native range. Interestingly, they cite Darwin’s comments on how some plants from tropical regions do surprisingly well in the climate of England, even though they are not found anywhere in nature in a similar climate. Rodda et al. (2011) claim that the method they used in 2008 was intended to identify the fundamental climate space of *molorus/bivittatus*.

The **realized climate space** of a species is the climate space that is defined by the native range of the species. According to Rodda et al. (2011), realized climate space does not indicate the potentially much greater tolerance of a species to wider variation in the variables that are used to define the climate space. Rodda et al. (2011) define the analysis of Pyron et al. (2008) as having generated a map of the realized climate space. The realized climate space is always smaller than the fundamental climate space, as illustrated in Figure 3 of Rodda et al. (2011), and also as illustrated by the differences in the analyses of suitable climate space by Rodda et al. (2008) and Pyron et al. (2008).

An important point that has been missing from many arguments and discussions [particularly in the media] regarding the map of suitable climate for Burmese pythons in the continental USA published by Rodda et al. (2008) is that suitable climate is *not* the same thing as suitable habitat or potential range. While sunny Chattanooga, Tennessee, and beautiful Oklahoma City, Oklahoma, are predicted to be within the “suitable climate space” for *bivittatus* by Rodda et al. (2008) [highly unlikely], those predictions make absolutely no evaluation of the actual possibility that pythons could or would survive there when other biotic and abiotic factors that comprise the ecosystem and environment are considered. A map of suitable climate space *only* illustrates the area where one of a nearly infinite number of biotic and abiotic factors *may* be suitable for the survival and establishment of Burmese pythons. In the case of the analysis of the “fundamental climate space” for *molorus/bivittatus* defined by Rodda et al. (2008), an unknown amount of the area of fundamental climate space may not even actually have suitable climate. Rodda, Jarnevich, Reed, and a small group of colleagues eventually became known as the Giant Python Risk Analysis Partnership [GCRAP]. They did nothing to correct the false interpretation spread in the media that the map of Rodda et al. (2008) was a map showing where the python species could and would invade. In fact, evidenced by their statements as quoted by the media, they appeared to do much to encourage misinterpretation of that paper.

Rodda et al. (2011) describe how selecting the correct locality points and variables to use in the analysis is paramount to the process. They state that “overfitting” is a serious problem that is commonly encountered in MaxEnt analyses, and that this was committed by Pyron et al. (2008). The data set of Pyron et al. (2008) used a smaller number of locality points and incorporated 19 variables into the analysis.

Overfitting is a modeling error that occurs when the climate space model is too closely fit to a limited set of data points. Rodda et al. (2011) consider the data points chosen by Pyron et al. (2008) that were based on localities of museum specimens or published locations from within the native range to be an example of overfitting. They maintain that the resulting model—based on a conservative realized climate space—underpredicted the suitable climate space when applied to new geographic localities.

Rodda et al. (2011) also warn against “data dredging,” that being the inappropriate selection of data points and variables from a large pool of possible variables; this practice can uncover misleading relationships in data. MaxEnt makes choosing and changing variables simple; researchers using MaxEnt can easily modify the variables in their analyses and create multiple climate space models until accidentally a model is generated that closely fits the native range. The possibility then exists that the resulting best climate model is the result of random variables that actually do not best describe the native climate space.

Rodda et al. (2011) state that Pyron et al. (2008) dredged to get their model. On the other hand, Rodda et al. (2011) state that they avoided the possible trap of data dredging by considering only models that were based on a priori assumptions. They then state that their choices of the locality points that comprise their data set are based on four variables, their a priori assumptions: mean monthly temperature, mean monthly precipitation, duration of hibernation and duration of estivation.

Once a climate space model is generated, it is then fitted on a global map to illustrate the geographic areas where the estimated suitable climate space exists. Rodda et al. (2011) list four tools that can be used to screen out unacceptable climate matching models. They are as follows:

- **Native Range Inclusion.** After a climate space model is generated and fitted to a global map, one test of accuracy is just how closely the climate space fits to the actual native range of the species.
- **Minimum Training Presence.** MaxEnt simultaneously analyzes two data sets, a training data set and a test data set, and then by comparing the two analyses using several different metrics the model accuracy can be estimated. Minimum training presence is a value generated by MaxEnt that measures the ability of the model to discriminate the training data set from the test data set. The minimum training presence criterion is a metric of the logistic threshold that results in inclusion of all training presences [see: http://plantecology.syr.edu/fridley/bio793/R_apr12_notes.htm]. We note that Phillips, the creator of MaxEnt, does not mention minimum training presence as an important tool when determining the accuracy of a model in an online MaxEnt Tutorial.

- **Overfitting.** Statistically there is danger to the accuracy of a model if the data set is either too simple or too complex. However, there is no agreed upon way to determine when a data set is correctly complex. Different modelers will incorporate totally different degrees of complexity into their analyses, and it seems that ultimately the measure of a correct model is that it fits the objective of the modeler. Herein lies some of the subjectivity that plagues climate space models.

According to Wikipedia, overfitting may occur when a model is excessively complex, such as having too many parameters relative to the number of observations. A model which has been overfitted will generally have poor predictive performance, as it can exaggerate minor fluctuations in the data. Overfitting is basically using more parameters (or less data) than necessary to create a model. Rodda et al. (2011) criticize the MaxEnt analysis of Pyron et al. (2008) as being overfitted, stating that by too tightly describing the climate space in the native range of *molurus/bivittatus*, the consequence was an overconservative climate space model that underpredicted the suitable climate space in the continental USA.

- **Eco-plausibility Test.** This is a test of the climate model when fitted on the global map. If a model predicts that there is suitable climate for *molurus/bivittatus* in Alaska, the Aleutian Islands, the Sahara desert, or Oklahoma City, even if this model closely approximates the native ranges of these taxa, it does not pass the eco-plausibility test.

When a climate space model is generated and then is judged to have failed the eco-plausibility test when fitted to the global map, the modeler then changes the locality points and/or the variables and then creates another model. This can continue until a model is created that fits the objectives of the modeler and adequately satisfies these four tests. This is the most basic fault and flaw of climate modeling; there are no standard protocols to carry it out (Engeman et al., 2011). It looks very scientific while being subjective and often not repeatable, testable or provable.

The validity of the climate space model of Rodda et al. (2008)

Rodda et al. (2011) do not answer the criticisms that have been leveled at the analysis of Rodda et al. (2008) responsible for the climate space model predicting that the climate of the southern third of the continental USA was suitable for *molurus/bivittatus*. We make the following points:

1. It remains that the analysis of Rodda et al. (2008) incorrectly included the native range of *Python molurus*. It is only *Python bivittatus* that is established in south Florida. It makes no difference that Rodda and most of the GCRAP camp continue to consider *bivittatus* as a subspecies—even as such it is a valid taxon with a discrete range. The only possible justification for the inclusion of *molurus* in the analysis was that it dramatically increased the geographic area fitted to the resulting suitable climate model.

In the years that have passed since Rodda et al. (2009), they have not performed a separate analysis restricted to *bivittatus* and it does not appear their superiors have insisted on it. We suspect that this is because the resulting climate model would

likely contradict and invalidate the exaggerated suitable climate predicted by their analysis, which formed (incorrectly) the basis for much subsequent funding and research, as well as the federal action to add many of the great constrictors to the Injurious Wildlife List (see Nolen [2012] for an overview).

2. The map of the native ranges of *molurus/bivittatus* generated by Rodda et al. (2008) is novel and incorrect in many of its details. Several areas are significantly expanded; such expansions are not supported in the literature and incorrectly increase the range of *molurus/bivittatus* too far west into Pakistan and north in China. [See Barker and Barker, 2010b, c.]

3. The four a priori assumptions identified in Rodda et al. (2011) as the basis of the hypothesis on which the analysis is based are incorrect for the following reasons:

First they did not set limits for the ranges of variation for the variables of mean monthly temperatures and mean monthly precipitation. This may be reasonable in an analysis where the locality points are within the native range of *molurus/bivittatus* [such as the presence points used in the analysis of Pyron et al. (2008)]. However, we question that there is a sound basis for a modeler to use variables from non-presence localities that exceed the limits of variation at presence localities. Exceeding these limits is based solely on the subjective judgment of the modeler and cannot be defended. If a modeler chooses data from non-presence locality points that exceed the range of variation observed at presence locality points by, say 5°C, why then not 10°C, or more? When the locality points are located well outside of the native ranges of *molurus/bivittatus*, as is true in this analysis, it seems obvious that it is necessary to identify a range of variation based on presence localities in the native range and exclude locality points where that range is exceeded.

The variation of mean monthly temperatures for the analysis of Rodda et al. (2008) ranges from mean monthly lows of 1°C at Nanyue, Hunan, China, to a mean monthly high of 37°C at Jacobabad, Pakistan. Both of these localities are significantly outside the native ranges of the two species.

As pointed out in Barker and Barker (2010a), mean monthly temperature is an incorrect and unsuitable variable. This is clearly evidenced by the python die-offs in the winters of 2009 and 2010 (Dorcas et al., 2011; Avery et al., 2010, and Mazzotti et al., 2010). The mean monthly temperatures in the areas of those die-offs were significantly greater than the minima at several of the extralimital localities used in the analyses of Rodda et al. (2008). Better variables would have been daily critical thermal minima or weekly mean thermal minima (Barker and Barker, 2010a; Engeman et al., 2011).

Second, mean monthly precipitation is an incorrect and unsuitable variable because of the incorrect map used by Rodda et al. (2008). The range of *molurus* illustrated by this map is expanded into southeastern Pakistan into exceedingly xeric habitat. Beyond that, Rodda et al. (2008) selected locality points that were further outside even the exaggerated map. We note that the minimum values of mean precipitation for both month and year are from Jacobabad, Pakistan—an extralimital locality. In fact, eight of the nine locality points with the lowest mean annual precipitation are non-presence localities and five are

extralimital to the native range of *molurus* (Barker and Barker, 2010c). These choices of both extralimital locality points and precipitation extremes that exceed any reported in python-presence localities certainly skew any model based on these data.

Third, the climate model of Rodda et al. (2008) is based on the authors' a priori assumption that Burmese pythons can and do hibernate in nature. This is without valid basis in the literature and has been experimentally demonstrated to be false in Mazzotti et al. (2010), Avery et al. (2010), Dorcas et al. (2011), and Barker (2008). Cota (pers. com.) reports that Burmese pythons in Southeast Asia are found at low elevations, usually below 200 m and very rarely higher than 1000 m. The assumption of hibernation, in particular, allowed the authors to choose locality points in China that are significantly extralimital.

Fourth, likewise, the a priori assumption that Burmese pythons estivate is necessitated by the authors' choices of locality points with extreme temperature maxima. This assumption is a rationalization to explain how pythons could survive in [extralimital] Jacobabad with **three consecutive months of mean temperatures of 35–37°C**. Indeed, pythons must occasionally seek shelter from high temperatures but this behavior is not necessarily estivation. The ability of pythons to undergo the slowing of metabolism necessary to correctly be identified as estivation is unknown and not supported in the literature.

In other words, all a priori assumptions on which the climate model of Rodda et al. (2008) are based are incorrect.

A comparison of the two climate models

We compare the climate models and predictions of Rodda et al. (2008) and Pyron et al. (2008) using two of the four tests described in Rodda et al. (2011) and discussed here earlier. Two of the tests—minimum training presence and overfitting—could not be used in a comparison as those values are not available for the analysis of Rodda et al. (2008).

Native Range Inclusion: The climate space model of Pyron et al. (2008) very closely approximates the native ranges of *molurus/bivittatus* and is distinctly superior to the model of Rodda et al. (2008) [see Figures 3 and 4]. That of Rodda et al. (2008) grossly overestimated the range of *bivittatus* in China, with an estimated 60% or more of the predicted Chinese range well outside the known native range (Barker and Barker, 2010b). Suitable climate is predicted in China north to Shandon Province, at least 6 degrees of latitude north of the known range of *bivittatus* in China. Additionally the model extends into the Himalayan Mountains, onto the Tibetan Plateau, all of Pakistan, and northwest into Iran, and in Turkmenistan and Tajikistan north of 40°N latitude, there to continue west off the map—all far outside the native range of *molurus*. It also includes all of the Malaysian Peninsula and all of Indonesia that is illustrated.

Eco-plausibility Test: At this time the predicted suitable climate model of Pyron et al. (2008) seems to be nearly exactly correct (Figure 1). This model identifies only southern Florida and limited areas of Cameron County at the southern tip of Texas. The observed die-offs of pythons due to the cold winters of 2009 and 2010, as reported in Dorcas et al. (2011); Avery et al. (2010); and Mazzotti et al. (2010), combined with the subse-

quent significant drop in reports of pythons in 2011 (173) and the first quarter of 2012 (23) appear to support the predictions of Pyron et al. (2008). More importantly, this illustrates the inaccuracy of the a priori assumption of Rodda et al. (2008) that Burmese pythons are capable of hibernation.

We point out that despite possible suitable climate, there are both biotic and abiotic factors that exclude *bivittatus* from establishing in South Texas. Most obvious is the absence of a 1.5-million-acre swamp that is a protected national park. The probability of the establishment in South Texas of any large alien snake species approaches zero when factors of intensive agriculture, human presence, automobile traffic, severe habitat disturbance and alteration, generally xeric conditions, and more, are considered.

In comparison, the suitable climate model of Rodda et al. (2008) fails the eco-plausibility test. This model includes the Eastern Seaboard north to include Washington, D.C., and the Eastern Shore of Maryland. The model includes a wide swath across the southern continental USA, including: Arkansas and parts of southern Tennessee; most of Oklahoma and barely into Kansas; essentially all of Texas; southern New Mexico and Arizona; parts of Utah and southern Nevada; and most of California. Winter temperatures of -27°C (-17°F) have been recorded in Oklahoma City—this is an area well within the area of suitable climate mapped by Rodda et al. (2008). The mapped suitable climate appears to include all of northern Mexico.

It is difficult to further evaluate the eco-plausibility of the suitable climate model of Rodda et al. (2008), as the authors do not display the areas of Latin America, Africa, Europe and Australia that are predicted to be suitable. However, based on such predictions of the model as are evidenced in Figures 2 and 4, it seems likely that this model indicates as suitable essentially all land areas around the globe between 30°N latitude and 30°S latitude, and even beyond that in some areas.

Criticisms of the model of Pyron et al. (2008)

The general criticism of Rodda et al. (2011) is that the model of Pyron et al. (2008) looks at realized climate space rather than fundamental climate space. Further, mention is made that the data may be overfitted by using 19 variables in the MaxEnt analysis, and that the authors committed data dredging when analyzing their data. A specific mistake noted by Rodda et al. (2011) is that Pyron et al. (2008) mistakenly incorporated four localities into their data set of 90 locality points that are localities of *Python brongersmai*. These four locality points are located close together in southern Thailand.

It is hypocritical that Rodda et al. (2011) criticize Pyron et al. (2008) for accidentally incorporating the four non-presence localities in the area of the Isthmus of Kra into their locality data set when the furthest of these from known Burmese python localities is 150 km (Cota, 2010) and all are well inside the area of suitable climate predicted by Rodda et al. (2008). We question how these four localities differ from the 142 non-presence points in the data set of Rodda et al. (2008), particularly in light of the fact that 29% of those localities lie outside the native ranges of *molurus/bivittatus* (Barker and Barker, 2010c). Rodda

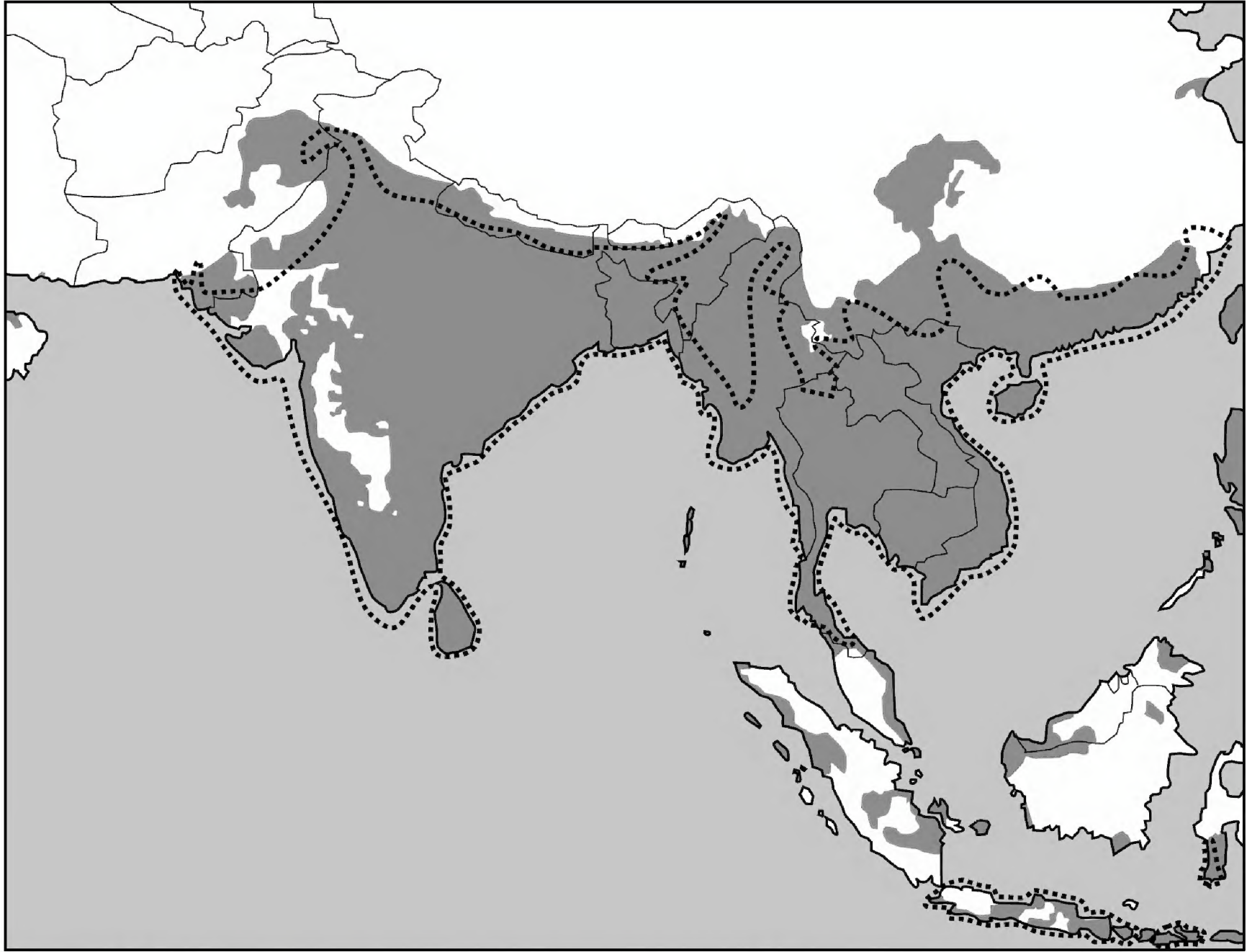


Figure 3. The dotted line represents the borders of the combined native ranges of *Python molurus* and *Python bivittatus* (Barker and Barker, 2010c). The dark-shaded areas represent suitable climate in the native range as predicted by Pyron et al. (2008).

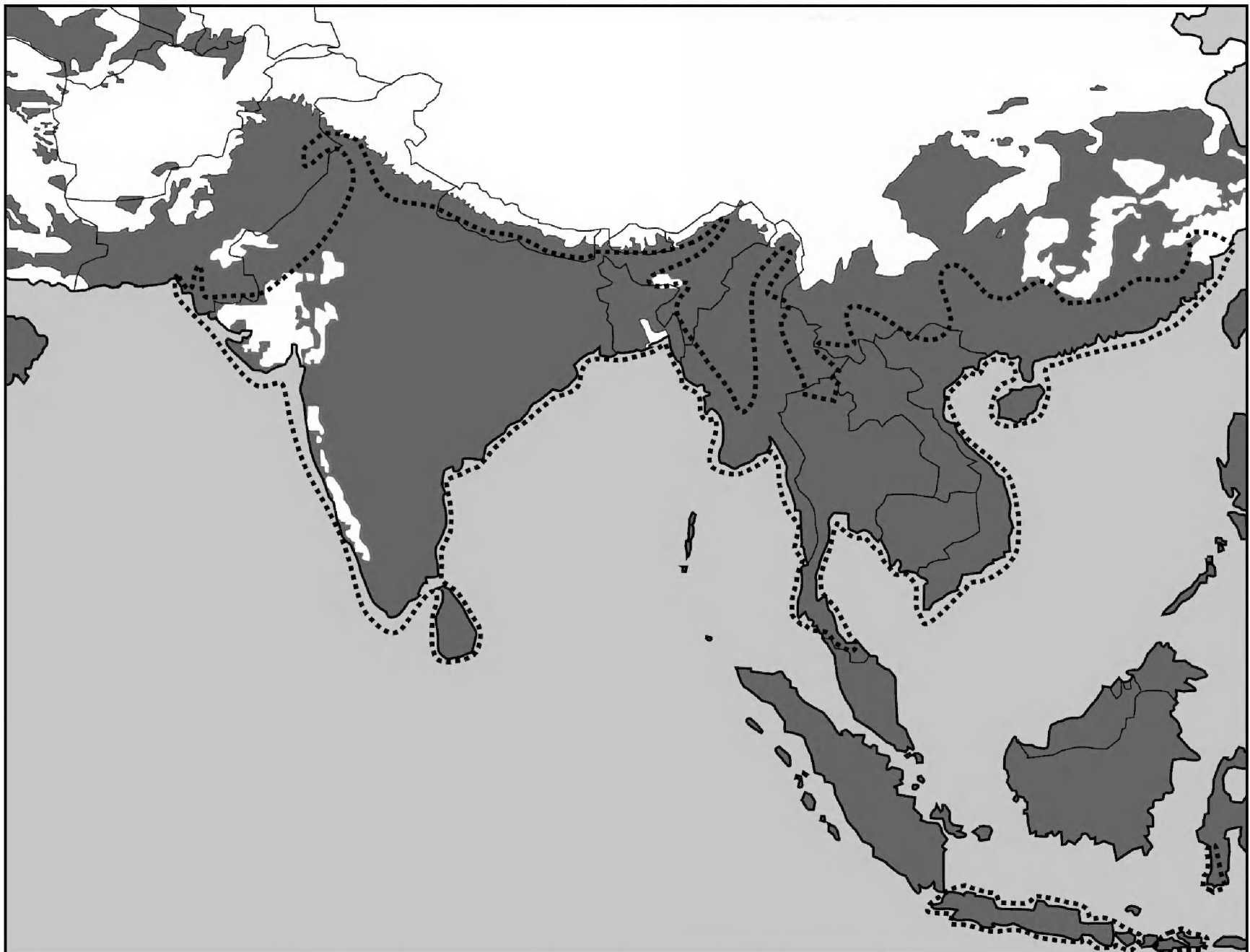


Figure 4. The dotted line represents the borders of the combined native ranges of *Python molurus* and *Python bivittatus* (Barker and Barker, 2010c). The dark-shaded areas represent suitable climate in the native range as predicted by Rodda et al. (2008).

et al. (2011) even warn against the use of localities that might represent “sink habitats,” those being aberrant outlier localities based on presence, yet they include many outlier non-presence localities in their data set, with many of them, such as the four in Hunan Province, hundreds of kilometers outside the native range of either species. As the most extreme example, Rodda et al. continue to include in their data set the anecdotal report of Liu (1986) [incorrectly cited as Deyang, 1986] of a dead Burmese python found crushed in a parking lot in northern Sichuan Province, approximately 1600 km north of the native range of *P. bivittatus*. [See Barker and Barker (2010b) for discussion of the two reports of *P. bivittatus* from Sichuan.]

We note that the data set on which the analysis of Pyron et al. (2008) is based also combines the two taxa, *molurus* and *bivittatus*. We assume this was, at least in part, for reasons of comparison to the model of Rodda et al. (2008). Indeed, in 2008 the taxon *bivittatus* was considered to be a subspecies of *Python molurus*; nevertheless, only a single taxon, *bivittatus*, is established in southern Florida and analyses should have been restricted to this single taxon (Barker and Barker, 2010c). Therefore—as with the model of Rodda et al. (2008)—the inclusion of *Python molurus* in the analysis invalidates any conclusions or predictions regarding Burmese pythons that could be derived from the model of Pyron et al. (2008).

Criticisms of the model of Rodda et al. (2008)

Pyron et al. (2008) state that the analysis of Rodda et al. (2008) deviates from normal protocol and may be underparameterized. This has resulted in an overprediction of the present-day distribution of *molurus/bivittatus* in their native ranges, which, in turn, raises the possibility that the subsequent predictions for the United States are overly broad in representing potential areas of further colonization.

Rodda et al. (2011) do not specifically or directly address any of the criticisms that have been made of the climate model of Rodda et al. (2008) by Barker and Barker (2008, 2010a, b, c). However, many of the issues that we raised in those papers are answered indirectly in their paper through the opinions of the authors on the importance of fundamental climate space versus realized climate space.

No matter whether those opinions are valid or not, and despite their explanations, the model of Rodda et al. (2008) is based on two taxa, one of which is irrelevant to this problem. Furthermore, the analysis is based on four false a priori assumptions; locality points were chosen without consideration of the presence or absence of pythons with only 7 of 149 records based on presence; and a significant number of locality points used in the analysis are far outside the native ranges of both *molurus* and *bivittatus* (Barker and Barker, 2010c).

The argument of Rodda et al. (2011) for the importance of fundamental climate space (an overestimated projection) boils down to “better safe than sorry”; i.e., it is better to overestimate rather than underestimate potential suitable climate space for invasive species. It must be a great temptation for a modeler to overestimate any climate model. An underestimated model may eventually be proven wrong. An overestimated model is never

wrong—it just hasn’t happened yet. This logic makes all climate models suspect.

Rodda et al. (2011) have applied this precautionary principle to overestimate even beyond the fundamental climate space. The flaws we have specifically pointed out in the data set of this analysis (earlier in this text and more in Barker and Barker, 2010c) are obvious, and egregious, raising the question of how this could pass internal departmental and journal review. The authors didn’t even restrict their locality points to within the boundaries of their own exaggerated range map. Twenty-nine percent of the locality points in the data set do not lie within the native ranges of either python species [some are more than 1000 km outside the native ranges] and many locality points far exceed reasonable limits of habitable elevation.

Conclusion

One of the weaknesses of climate match modeling is its subjectivity. Such models ignore countless critical biotic and abiotic factors of ecosystem and environment, many of which are interlinked and some of which are stochastic and unpredictable. Undoubtedly most climate modelers attempt to use maximum objectivity when obtaining and analyzing data, but because they don’t have to, this type of analysis is weakened and draws suspicion to every such model. Engeman et al. (2011) point out that there are no set protocols for climate match modeling, which can lead to such highly divergent results as those of Pyron et al. (2008) and Rodda et al. (2008).

According to Rodda et al. (2011), the model of Pyron et al. (2008) is overfitted and the predictions of suitable climate or ecological niche are too conservative. According to Pyron et al. (2008), the model of Rodda et al. (2008) is too simplistic and based on a biased and inaccurate data set that led to exaggerated predictions. Based on our analysis, both models are flawed and incorrect.

The model of Rodda et al. (2008) was used as a component in a publicity campaign. This is clearly evidenced by the press releases from USGS and the media frenzy that followed. The authors and their colleagues gave misleading and deceptive interviews in the weeks and months that followed the release of the paper, all serving to overstress and amplify the potential problems and dangers of Burmese pythons in south Florida, none of which have actualized in the years that have followed.

The USGS, USFWS, and the Department of the Interior made no attempt to correct the misinformation generated by their employees that was rife throughout all media. There was no effort made to communicate with either the media or the public to explain that the predictions of a climate model are not an actual view into the future. This model proposed to predict only suitable climate and was not any prediction of suitable habitat, suitable niches, or future distribution. The strength of any ecological model depends on the accuracy of the data on which the predictions are based; even the strongest models cannot create or control the future. Predictions for systems as complex and highly integrated as the environment and ecosystems are only guesses, not truths.

Federal regulations that list Burmese pythons, Indian pythons, and three other great constrictors on the Injurious Wildlife list were based largely on the flawed predictions of Rodda et al. (2008). This is at a huge cost (Nolen, 2012), financial and

otherwise, to tens of thousands of American citizens who keep snakes. At the very least, a valid reanalysis should be conducted, preferably in conjunction with a retraction of Rodda et al. (2008) and Reed and Rodda (2009).

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What You Missed at the May Meeting

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It's wrong, I know. I shouldn't be such a sucker for neat graphics, pretty pictures or great organization. Much meat can be found hiding away from the dazzle of the superficial. There are many ideas that are worth the trouble of wading through complicated, poorly written, and lightly illustrated papers, books and presentations. But, it's so much more fun when someone has already done the hard work for you and can present potentially complicated concepts in an interesting, clear, and dare I say, entertaining manner. Call me lazy . . . wait, I'll call myself lazy, but Dr. Tony Gamble's presentation was a perfect example of how I wish all of my college lectures could have been prepared and delivered. If that had been the case, I might have even gotten grades I could brag about (Hey! I *did* graduate. Mostly because I think the school didn't want me hanging around any more).

When I met Tony I mentioned how much I liked his web site (<http://www.tc.umn.edu/~gamb1007/>). He seems to be an open and forthright individual and expressed surprise at my praise. He didn't think it was that good, but he's got PDFs of his many papers, interesting links and cool photos from his field trips. Commenting on a couple of his photos elicited the stories associated with them, and I delighted in the details involved in the acquisition of the pictures. He's an easy guy to like, and not just because we share a similar hairline. His web site shows diverse interests, but we were going to receive information on his primary focus, geckos.

Here's what Tony writes about himself on his web site: "I am a postdoctoral researcher in Dave Zarkower's lab at the University of Minnesota. I use phylogenies to study biogeography, speciation, taxonomy, and the evolution of novel traits in amphibians and reptiles. My current research examines the evolution of sex determining mechanisms in reptiles."

Using geckos, he was to give us a brief glimpse of nearly everything that his studies pursue, educating us with a well-written, well-organized, humorous presentation illustrated with pretty pictures and neat graphics. He titled it, "Ancient Lands and Sticky Hands: Gecko Biogeography and Evolution."

Tony started by giving us some definitions and explanations that would allow us to more easily appreciate his points. Phylogenies are evolutionary trees showing the relationships between organisms and ancestors. They are constructed with branches that fork from nodes representing the organisms and their ancestor. A clade is an ancestor and all its descendants, and they can nest within one another. Tony used excellent graphics to demonstrate these terms, and I suggest that one can find much information about these terms in better places than this article if you are still uncertain.

Next he gave us a little background on model organisms,

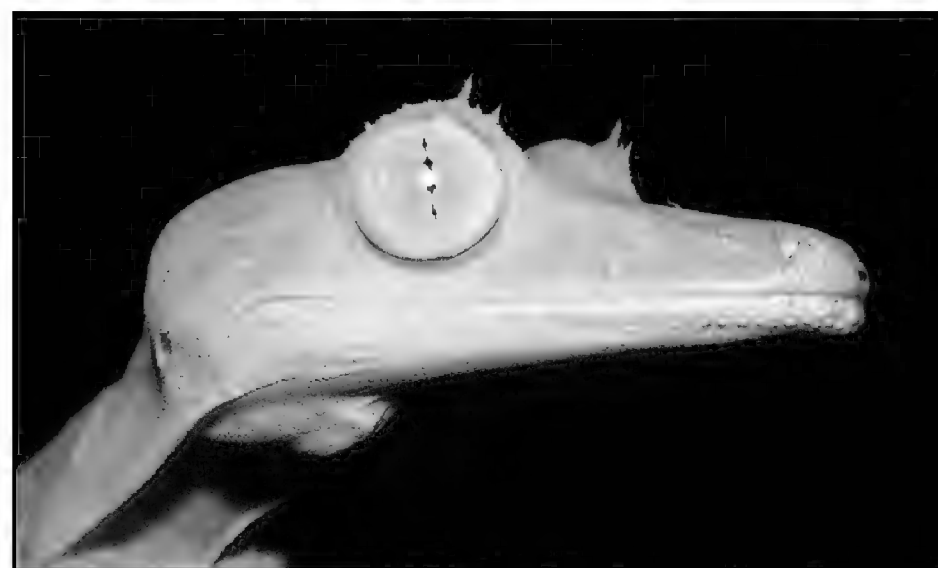


Tony Gamble. Photograph by Dick Buchholz.

showing a quote from August Krogh illustrated with a great belly shot of a gecko: "For a large number of problems there will be some animal of choice or a few such animals on which it can be most conveniently studied."

Scientists can use model organisms to represent other groups of animals that may be impossible to study otherwise. Mice and fruit flies are perhaps the best known such models. Repeated or convergent evolution in a well-chosen model can allow scientists to draw conclusions about the evolutionary process. Statistical analysis of DNA can even allow researchers to deduce traits of extinct ancestors.

Then Dr. Gamble defined geckos. Of course he began with a slide illustrating that geckos are the only reptiles that sell insurance, but they are so much more. As of the week before his presentation geckos consisted of 1,482 species in 118 genera, with over 30 new species having been described in each of the last six years. Most geckos actively vocalize, have sticky toe pads, no eyelids, nocturnal habits, and a fixed clutch size of two eggs, though exceptions exist to all of these traits. They have a global distribution that tends to favor alluring climates and are accessible to scientists working nearly everywhere. They have an ancient lineage, emerging during the Triassic, and are the sister clade to all other squamates with the exception of dibamids (look them up). They are morphologically diverse, ranging in size from the now second-smallest vertebrate (*Sphaerodactylus ariasae*), illustrated sitting on a dime that Tony claimed was the only way anyone ever photographed them, to a probably extinct species (*Hoplodactylus delcourti*) represented by one known specimen a little smaller than a house cat shown being held by someone Tony was pretty sure was Dracula (lighting is everything in a photograph). Geckos are easy to care for and easy to breed. As you may have figured out by now, all of these things make geckos a nearly ideal model for the study of many questions. Thanks to a refined phylogenetic tree illustrating several cases of repeated evolution, they're particularly useful in modeling evolution.

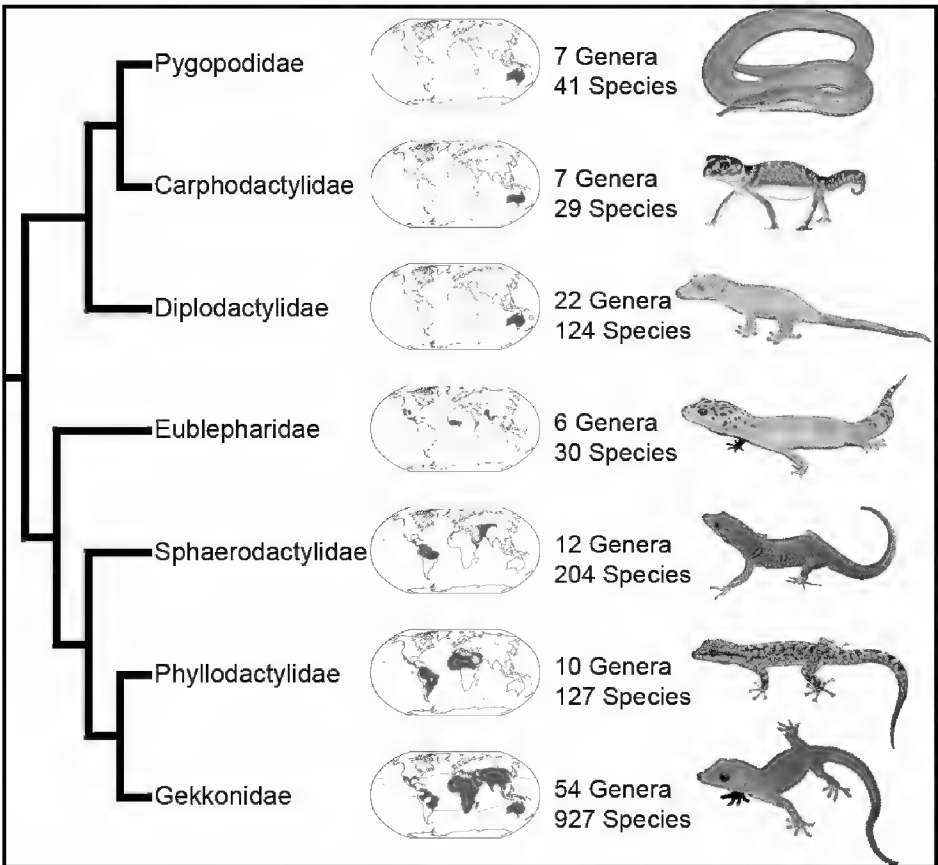


Lined flat-tailed gecko, *Uroplatus lineatus*.

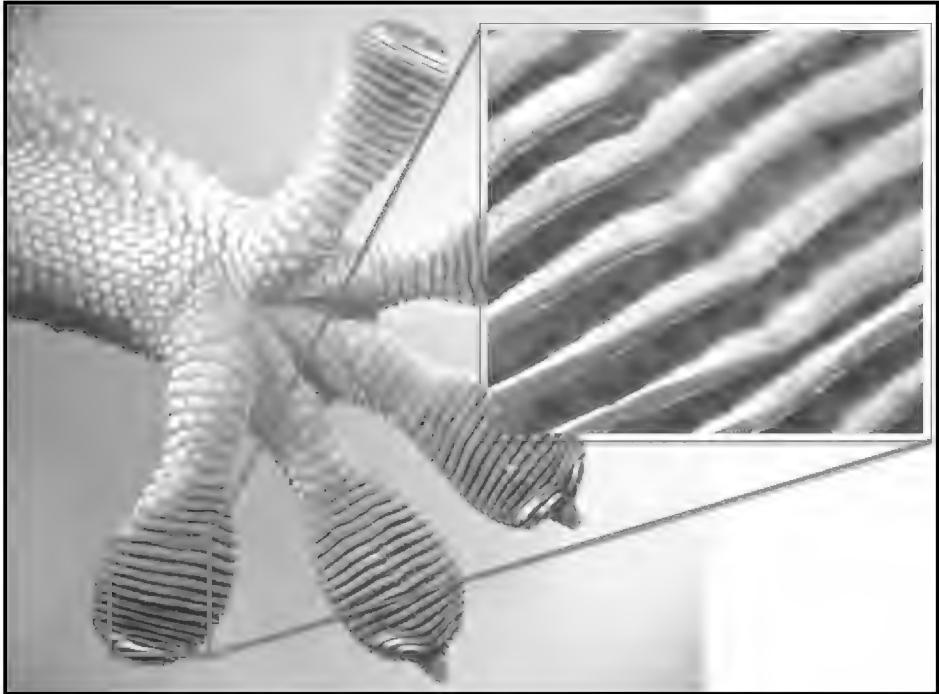
I thought that Tony’s next topic was really interesting but unfortunately I can’t reproduce his presentation as he charted the progress of gecko taxonomy from Fitzinger in 1843 to the present. Using colors and clades he revealed the evolution of gecko phylogeny from early scientists using morphological characteristics to present-day efforts using DNA. Step-by-step he moved us through the attempts to wrest order from a most confusing taxon, along the way convincing us of the value of DNA analysis, especially where repeated evolution had occurred. This part of his talk would be dry and boring if I attempted to describe it, but as Tony moved through the history of gecko systematics, it was a delight to be able to follow the mistakes, and often the reasons for them, of his predecessors. At the same time Tony admitted that the refining is ongoing. As he talked, I realized Dr. Gamble had not only convinced me of the value of accurate taxonomy, but had also made a discipline I had thought boring into something I now looked upon with interest.

Tony then used brilliant maps and colorful graphics to elucidate how a proper phylogeny could shed light on the biogeography of geckos. He worked us through the conclusions generated from a close study of the 162 species of New World geckos and their place on the phylogenetic tree. A graphic of a time-calibrated phylogeny using multiple fossils and biogeographic calibrations enabled Tony to lead us through his thoughts on what species probably were present in the New World when Gondwanaland broke up, what species probably dispersed over the seas, species that may have crossed land bridges, and what species were likely introduced by humans to the new world. Geckos are known to be exceptionally capable of dispersing over water, inhabiting volcanic islands far from other land. Some species not only have sticky toes but also sticky eggs that may cling to flotsam for long periods. Some eggs can even survive immersion in salt water for several days.

So far Dr. Gamble had discussed the history and thinking behind gecko phylogeny and explored an aspect of the biogeography of his favorite reptile with us. Along the way he captured our attention by discussing the importance of correct taxonomy. Now he moved into what sticky toes could reveal to an inquisi-



Family relationships among the Gekkota.



Adhesive toe pads of a species of *Tarentola*.

tive mind. Reflecting the morphological basis of early taxonomists, *dactylus*, which means digit or toe in Latin, appears in the names of about 25% of all gecko genera. As diverse as gecko toes are, using them appears at first glance to be an excellent way to differentiate clades in geckos, but DNA analysis has revealed a phylogeny indicating that sticky toes have repeatedly evolved in unrelated gecko taxa. But before diving into that area, Tony showed us how those those sticky toes work. Cool electron photomicrographs, showed setae with bristly ends that make up the lamellae lining the bottom of gecko toes. Using weak Van der Waals forces, each tip of these minute structures exerts a slight attractive force. The tokay gecko (*Gekko gecko*) has six and a half million of these, together capable of exerting a holding force of 290 lbs. While all of the setae are never in contact with another surface at one time, a 50-gram (about a tenth of a pound) lizard has no problem running across a ceiling with only a small portion of its toes in contact.

Tony used gecko phylogeny to show us clear cases of repeated evolution of these extraordinary toes, also demonstrating specific instances of unambiguous gaining of sticky toes from a non-sticky ancestor and unambiguous loss of stickiness from a sticky ancestor. Without an accurate phylogeny, these cases would have been impossible to discern. Again he carried us through a relatively complicated explanation with excellent graphics and always-cool pictures of geckos. He discussed the probability of evolving these complicated structures, showing us how all reptiles have setae on some scales, but geckos have them everywhere, and especially on the toes. Showing examples of different degrees of modifications, he showed us how a series of step-by-step changes in the lizards’ skeletons, muscles, tendons, and of course lamellae, could lead to a house gecko sprinting across the ceiling with ease.

And with ease is how I took in Tony Gamble’s presentation. In about an hour he gave us insights into a complicated and often obscure area of biology by choosing and designing excellent graphics, enlivening it with neat gecko photos, and organizing it so that even I could follow his thinking. He also gave us a quick view of what is in store with gecko studies in the near future. When Tony gains a professorship, I’d like to audit his class. He’s the type of guy that can make even me feel smart.

Unofficial Minutes of the CHS Board Meeting, May 18, 2012

The meeting was called to order at 7:40 P.M. at the Schaumburg Public Library. Board members Barbara Khan, Deb Krohn and Jenny Vollman were absent.

Officers' Reports

Recording Secretary: In Jenny's absence, Mike Dloogatch read the minutes from the March 16 board meeting.

Treasurer: Andy Malawy presented the financial reports for February, March and April. He also presented a preliminary financial report for ReptileFest.

Vice-president: Cindy is looking for different ways to publicize CHS meetings and speakers.

Membership Secretary: Mike Dloogatch shared the list of recently expired memberships. We gained at least 10 members over the past month.

Sergeant-at-arms: Cindy reported counting 58 people at the April general meeting.

Committee Reports

Shows:

Dick wants to put out donation cans at some shows. His idea was to keep the money from the cans to cover expenses. Mike Dloogatch suggested that he turn in any such monies to the treasurer, supply receipts, and get reimbursed with a CHS check instead. Dick agreed that this would be a good way to do it.

- Notebaert, first full weekend of each month. Josh Chernoff is coordinator.
- Cosley Zoo, May 19. Dick Buchholz is doing a turtle display.
- Meet the Creek, Kiwanis Park, Brookfield, June 9. Jenny is looking for volunteers.
- Rockin' for the Reptiles, Midwest Museum of Natural History, Sycamore, June 30. Dick is looking for volunteers.
- SEWERfest, August 5, 10-3. They donate a table to the CHS.

Adoptions: Linda has a ton of corn snakes and also box turtles, not to mention the red-eared slider and iguana calls. Bob has ball pythons and boas.

ReptileFest: Jason Hood went over a variety of things that were discussed at the 'Fest wrap meeting, including ideas for next year's 20th anniversary.

Old Business

Jason and Steve Sullivan are still working on organizing a Junior Herper Club.

National Herpetological Society: Jason reports not much going on. There will be a second conference call soon and he hopes things will get rolling and move forward.

New Business

Conservation donations: Jason Hood suggested that we look at donating some money to conservation efforts. The ones discussed were Amphibian Ark, massasauga studies, DAPTF, TSA, IRCF, Will and Dupage County Forest Preserve Districts. It was

the consensus that we need to gather a little more basic info so we can vote properly.

Steve Sullivan wrote a letter to *Chicago Parent* magazine objecting to an article they ran that included a photo of a gaboan viper being free-handled. Before mailing it, Steve emailed a copy to CHS board members to see if there were any objections or additions.

We need to order more "Come to the Meeting" magnets, and some basic office supplies.

Jason asked about the need to obtain photo releases if we use people's likenesses in a new membership flier. Bobby Delany and Mike Heinrich will work on this.

Cindy moved to give the Phipps family a free membership in thanks for Todd's work on the photo booth at ReptileFest. Lawrence seconded and the motion passed unanimously.

Cindy moved to make a donation of CHS merchandise to the ETHS Sanderson Snake Days. Aaron seconded and the motion passed unanimously.

Mike asked for volunteers to write up both of the June meetings for the *Bulletin*.

Jessica is doing a talk at an art convention and wanted to let the board know she will be discussing her involvement with the CHS.

Round Table

Nancy and Gary shared their artwork.

Jason has carpet pythons hatching.

The meeting was adjourned at 9:30 P.M.

Respectfully submitted by Cindy Rampacek



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For sale: **highest quality frozen rodents**. I have been raising rodents for over 30 years and can supply you with the highest quality mice available in the U.S. These are always exceptionally clean and healthy with no urine odor or mixed in bedding. I feed these to my own reptile collection exclusively and so make sure they are the best available. All rodents are produced from my personal breeding colony and are fed exceptional high protein, low fat rodent diets; no dog food is ever used. Additionally, all mice are flash frozen and are separate in the bag, not frozen together. I also have ultra low shipping prices to most areas of the U.S. and can beat others shipping prices considerably. I specialize in the smaller mice sizes and currently have the following four sizes available: Small pink mice (1 day old—1 gm), \$25 /100; Large pink mice (4 to 5 days old—2 to 3 gm), \$27.50 /100; Small fuzzy mice (7 to 8 days old—5 to 6 gm), \$30/100; Large fuzzy mice /hoppers (10 to 12 days old—8 to 10 gm), \$35/100 Contact Kelly Haller at 785-234-3358 or by e-mail at kelhal56@hotmail.com

For sale: High quality, all locally captive-hatched tortoises, all bred and hatched here in the upper midwest. Baby leopards, Sri Lankan stars, and pancakes usually available, and are all well-started and feeding great! Leopards are \$125 ea., Sri Lankans (2012 hatched) \$475 ea. And Pancakes are \$195 ea. Leopards for out of state sale/shipping require a veterinary health certificate (inquire for cost). E-mail at KKranz1@wi.rr.com or call Jim or Kirsten at 262 654 6303.

Herp tours: **Costa Rica herping adventures**. Join a small group of fellow herpers for 7 herp-filled days. We find all types of herps, mammals, birds, and insects, but our target is snakes. We average 52 per trip, and this is our 10th year doing it. If you would like to enjoy finding herps in the wild and sleep in a bed at night with air-conditioning, hot water and only unpack your suitcase once, instead of daily, then this is the place to do it. Go to our web-site <http://hiss-n-things.com> and read the highlights of our trips. Read the statistics of each trip and visit the link showing photos of the 40 different species we have found along the way. E-mail at jim.kavney@gmail.com or call Jim Kavney, 305-664-2881.

Line ads in this publication are run free for CHS members—\$2 per line for nonmembers. Any ad may be refused at the discretion of the Editor. Submit ads to mdloogatch@chicagoherp.org.



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UPCOMING MEETINGS

The next meeting of the Chicago Herpetological Society will be held at 7:30 P.M., Wednesday, June 27, at the Peggy Notebaert Nature Museum, Cannon Drive and Fullerton Parkway, in Chicago. This will be our popular and always well-attended annual **Show & Tell** meeting. Bring an animal that you find interesting for one reason or another and be prepared to give a short (under five minutes) presentation to the group. Don't be shy. Neither age (yours) nor commonness (the animal's) should be a limitation.

At the July 25 meeting **Gerry Salmon** of Boerne, Texas, will present a program on "Saving Herps --- One at a Time: Working as a Timber Rattlesnake Monitor on the Tennessee Gas Pipeline in Northern New Jersey and Northeastern Pennsylvania." Gerry has been an avid naturalist for most of his 51 years. He has a strong interest in herpetology and especially geographic distribution of North American reptiles and amphibians. He is also a long-term contributor to northeastern timber rattlesnake (*Crotalus horridus*) field biology and conservation efforts that became the basis for a recent seasonal job. His presentation consists of highlights of that work and is an opportunity to see some interesting herps of the Northeast. Gerry has spoken several times in the past at our monthly meetings on kingsnakes of the *mexicana* complex, timber rattlesnakes, and herping in South Carolina.

The regular monthly meetings of the Chicago Herpetological Society take place at Chicago's newest museum—the **Peggy Notebaert Nature Museum**. This beautiful building is at Fullerton Parkway and Cannon Drive, directly across Fullerton from the Lincoln Park Zoo. Meetings are held the last Wednesday of each month, from 7:30 P.M. through 9:30 P.M. Parking is free on Cannon Drive. A plethora of CTA buses stop nearby.

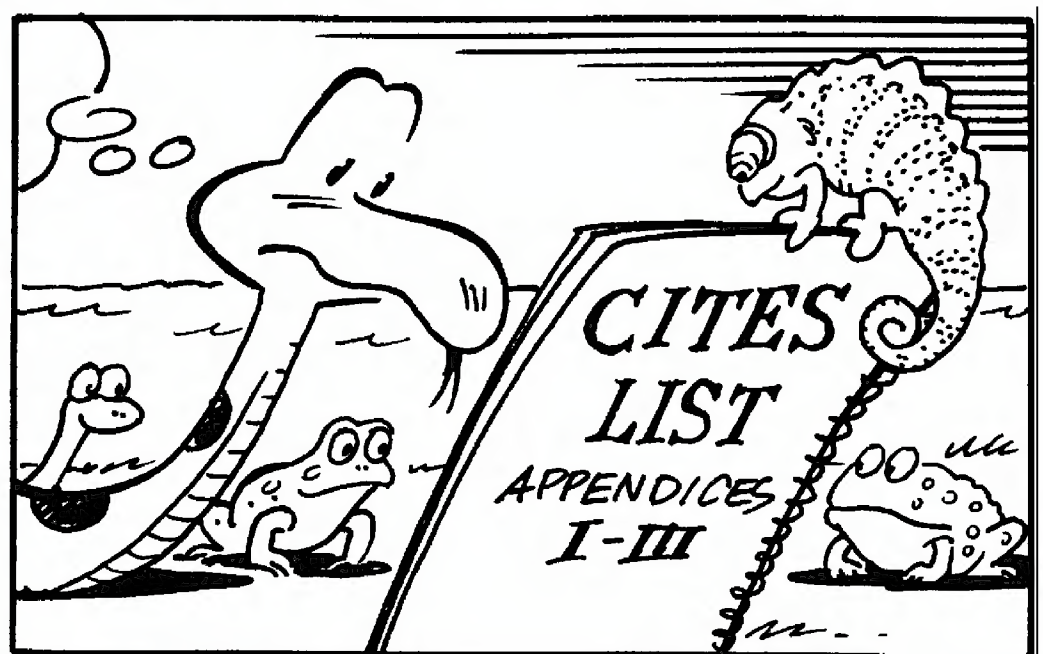
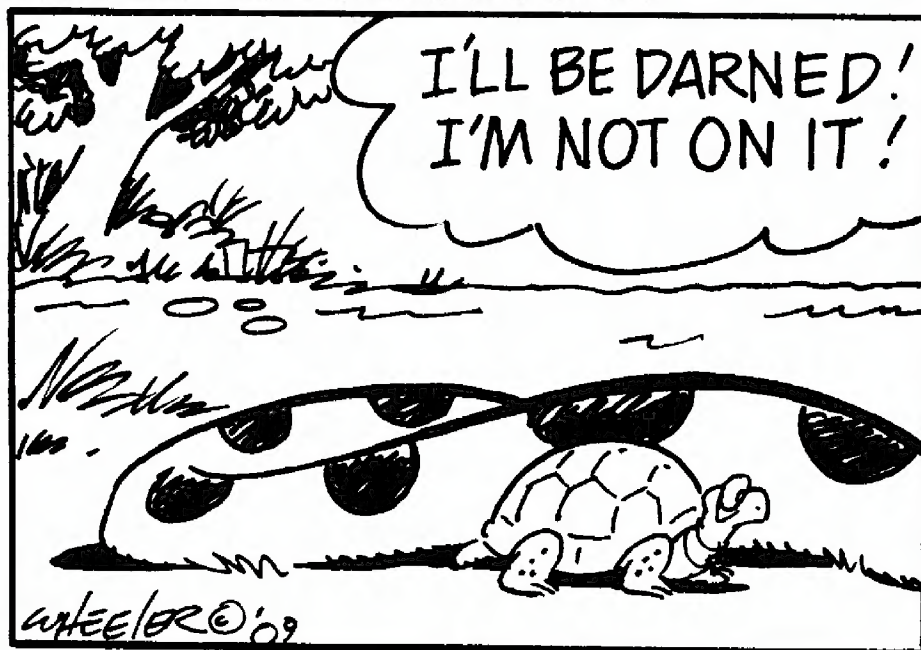
Board of Directors Meeting

Are you interested in how the decisions are made that determine how the Chicago Herpetological Society runs? And would you like to have input into those decisions? If so, mark your calendar for the next board meeting, to be held at 7:30 P.M., July 13, in the adult meeting room on the second floor of the Schaumburg Township District Library, 130 S. Roselle Road, Schaumburg.

The Chicago Turtle Club

The monthly meetings of the Chicago Turtle Club are informal; questions, children and animals are welcome. Meetings normally take place at the North Park Village Nature Center, 5801 N. Pulaski, in Chicago. Parking is free. For more info visit the group's Facebook page.

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